

WHAT IS CLAIMED IS:

1. A process for producing an ethylene/α-olefin/non-conjugated polyene copolymer comprising copolymerizing ethylene, an α-olefin and a non-conjugated polyene in a hydrocarbon solvent with use of a transition metal compound catalyst, and removing the unreacted monomers and the hydrocarbon solvent from the copolymer solution without removing the catalyst residue, wherein the copolymerization is carried out at a polymerization temperature of 100°C or above and a polymerization pressure of 2.7 MPa or above in a manner such that the non-conjugated polyene concentration in the polymerization solution is less than the maximum non-conjugated polyene concentration C_{max} (mol/L) indicated below:

C_{max} = 0.050 (mol/L) when the copolymer has an iodine value (IV) of 9.0 g/100 g to less than 17.0 g/100 g; or

C_{max} = 0.104 (mol/L) when the copolymer has an iodine value (IV) of 17.0 g/100 g or above.

2. A process for producing an ethylene/α-olefin/non-conjugated polyene copolymer comprising copolymerizing ethylene, an α-olefin and a

non-conjugated polyene in a hydrocarbon solvent with use of a transition metal compound catalyst, and removing the unreacted monomers and the hydrocarbon solvent from the copolymer solution without removing the catalyst residue,

5 wherein the copolymerization is carried out at a polymerization temperature of 100°C or above and a combined vapor pressure of the hydrocarbon solvent and the unreacted monomers of 2.7 MPa or above in a manner such that the non-conjugated polyene concentration in the polymerization

10 solution is less than the maximum non-conjugated polyene concentration C_{max} (mol/L) indicated below:

$C_{max} = 0.050$ (mol/L) when the copolymer has an iodine value (IV) of 9.0 g/100 g to less than 17.0 g/100 g; or

15 $C_{max} = 0.104$ (mol/L) when the copolymer has an iodine value (IV) of 17.0 g/100 g or above.

3. A process for producing an ethylene/α-olefin/non-conjugated polyene copolymer comprising copolymerizing ethylene, an α-olefin and a

20 non-conjugated polyene in a hydrocarbon solvent with use of a transition metal compound catalyst, and removing the unreacted monomers and the hydrocarbon solvent from the copolymer solution without removing the catalyst residue, wherein the copolymerization is carried out at a

polymerization temperature T (K) and a polymerization pressure P_a (MPa) in a manner such that the non-conjugated polyene concentration in the polymerization solution is less than the maximum non-conjugated polyene concentration C_{max} (mol/L)

5 indicated below:

$C_{max} = 0.050 \times \text{Iodine Value (IV)} \times 10^{12.25+1.16 \times \log P^a + 5.37 \times \log(1/T)}$ when the polymerization temperature is less than 353.16 K (80°C);

$C_{max} = 0.050 \times \text{Iodine Value (IV)} \times 10^{11.88+1.23 \times \log P^a + 5.23 \times \log(1/T)}$ when the polymerization temperature is from 353.16 K (80°C) to less than 393.16 K (120°C); or

$C_{max} = 0.050 \times \text{Iodine Value (IV)} \times 10^{19.02+1.61 \times \log P^a + 8.02 \times \log(1/T)}$ when the polymerization temperature is 393.16 K (120°C) or above.

4. A process for producing an ethylene/α-olefin/non-conjugated polyene copolymer comprising copolymerizing ethylene, an α-olefin and a non-conjugated polyene in a hydrocarbon solvent with use of 20 a transition metal compound catalyst, and removing the unreacted monomers and the hydrocarbon solvent from the copolymer solution without removing the catalyst residue, wherein the copolymerization is carried out at a

polymerization temperature T (K) and a combined vapor pressure P_b (MPa) of the hydrocarbon solvent and the monomers in a manner such that the non-conjugated polyene concentration in the polymerization solution is less than the maximum

5 non-conjugated polyene concentration C_{max} (mol/L) indicated below:

$C_{max} = 0.050 \times \text{Iodine Value (IV)} \times$
 $10^{\{12.25+1.16 \times \log P^b + 5.37 \times \log(1/T)\}}$ when the polymerization temperature is less than 353.16 K (80°C);

10 $C_{max} = 0.050 \times \text{Iodine Value (IV)} \times$
 $10^{\{11.88+1.23 \times \log P^b + 5.23 \times \log(1/T)\}}$ when the polymerization temperature is from 353.16 K (80°C) to less than 393.16 K (120°C); or

15 $C_{max} = 0.050 \times \text{Iodine Value (IV)} \times$
 $10^{\{19.02+1.61 \times \log P^b + 8.02 \times \log(1/T)\}}$ when the polymerization temperature is 393.16 K (120°C) or above.

5. A process for producing a copolymer comprising copolymerizing ethylene, an α -olefin and a non-conjugated 20 polyene in a hydrocarbon solvent, and obtaining a copolymer without removing the catalyst residue from the polymerization solution, wherein the copolymerization is carried out under conditions satisfying the formula (1):

Ethylene concentration in polymerization solution (wt%)	\times	Non-conjugated polyene concentration in polymer (wt%)	≥ 20	... (1)
Non-conjugated polyene concentration in polymerization solution (wt%)				

6. The process for producing an ethylene/α-olefin/non-conjugated polyene copolymer according to claim 5, wherein the copolymerization is carried out with 5 use of a transition metal compound catalyst in a manner such that the unreacted monomers and the hydrocarbon solvent are removed from the polymerization solution whilst the catalyst residue is not removed.

10 7. The process for producing an ethylene/α-olefin/non-conjugated polyene copolymer according to any one of claims 1 to 6, wherein the removal of the unreacted monomers and the hydrocarbon solvent is performed by evaporation.

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8. The process for producing an ethylene/α-olefin/non-conjugated polyene copolymer according to any one of claims 1 to 7, wherein the content of residual unreacted polyene in the copolymer is not more than 500 ppm.

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9. A process for producing an

ethylene/propylene/non-conjugated polyene copolymer according to any one of claims 1 to 8, wherein the transition metal compound catalyst is capable of catalyzing copolymerization of ethylene, propylene and a non-conjugated 5 polyene to give an ethylene/propylene/non-conjugated polyene copolymer having an ethylene content of 70 mol% and an iodine value of at least 15, when the copolymerization is carried out under conditions such that the polymerization temperature is 80°C, a reactor is employed which includes a gas phase and a 10 liquid phase, the ethylene and propylene of the gas phase have a combined partial pressure of 0.6 MPa or above, and the non-conjugated polyene of the liquid phase has a concentration of 15 mmol/L or below.

15 10. The process for producing an ethylene/α-olefin/non-conjugated polyene copolymer according to any one of claims 1 to 9, wherein the transition metal content in the copolymer is not more than 20 ppm.

20 11. The process for producing an ethylene/α-olefin/non-conjugated polyene copolymer, wherein the transition metal compound catalyst is a transition metal-containing polymerization catalyst comprising:
(A) a transition metal compound represented by the

following formula (I); and

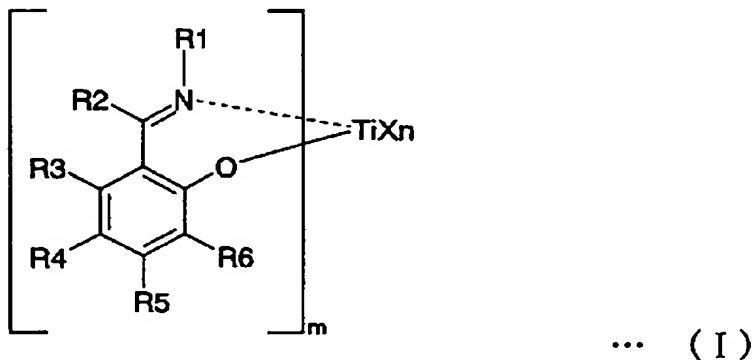
(B) at least one compound selected from (B-1) to (B-3):

(B-1) an organometallic compound;

(B-2) an organoaluminum oxy-compound; and

5 (B-3) a compound which reacts with the transition

metal compound (A) to form an ion pair:



wherein:

m is an integer of 1 to 4;

10 R1 to R5, which may be the same or different, are each a hydrogen atom, a halogen atom, a hydrocarbon group, a heterocyclic compound residue, an oxygen-containing group, a nitrogen-containing group, a boron-containing group, a sulfur-containing group, a phosphorus-containing group, a

15 silicon-containing group, a germanium-containing group or a tin-containing group; R6 is a group selected from aliphatic hydrocarbon groups in which the carbon bonded to the phenyl group is a primary, secondary or tertiary carbon, alicyclic hydrocarbon groups in which the carbon bonded to the phenyl

group is a primary, secondary or tertiary carbon, and aromatic groups; and two or more of these substituent groups may be bonded to each other to form a ring;

when m is 2 or greater, two of the groups R1 to R6 may 5 be bonded to each other (with the proviso that the groups R1 are not bonded to each other);

n is a number satisfying a valence of the titanium atom; and

X is a hydrogen atom, a halogen atom, a hydrocarbon group, 10 an oxygen-containing group, a sulfur-containing group, a nitrogen-containing group, a boron-containing group, an aluminum-containing group, a phosphorus-containing group, a halogen-containing group, a heterocyclic compound residue, a silicon-containing group, a germanium-containing group or a 15 tin-containing group, and when n is 2 or greater, plural groups X may be the same or different and may be bonded to each other to form a ring.

12. An ethylene/α-olefin/non-conjugated polyene copolymer comprising ethylene, an α-olefin of 3 to 20 carbon 20 atoms and a non-conjugated polyene, the copolymer being characterized in that:

(i) the Mooney viscosity at 100°C (ML(1+4)100°C) is 5 to 190 or the intrinsic viscosity $[\eta]$ at 135°C in decalin is 0.02 to 10 dl/g;

(ii) the copolymer contains ethylene in an amount of 50 to 98.9 mol%, the α -olefin of 3 to 20 carbon atoms in an amount of 1 to 49.9 mol%, and the non-conjugated polyene in an amount of 0.1 to 49 mol% based on 100 mol% of the combined ethylene,
5 α -olefin and non-conjugated polyene; and

(iii) the value B indicated below satisfies the formula
(2) :

$$B \geq (1/a - 1) \times 0.26 + 1 \quad \dots (2)$$

wherein $B = (c+d) / (2 \times a \times (e+f))$, in which a is an ethylene
10 molar fraction, c is an ethylene/ α -olefin dyad molar fraction, d is an ethylene/non-conjugated polyene dyad molar fraction, e is an α -olefin molar fraction, and f is a non-conjugated polyene molar fraction.

15 13. The ethylene/ α -olefin/non-conjugated polyene copolymer according to claim 12, wherein the non-conjugated polyene has a norbornene skeleton.

14. The ethylene/ α -olefin/non-conjugated polyene
20 copolymer according to claim 12 or 13, which provides a $^{13}\text{C-NMR}$ spectrum in which the intensity ratio $T\alpha\beta/T\alpha\alpha$ is 0.015 to 0.15.

15. The ethylene/ α -olefin/non-conjugated polyene copolymer according to any one of claims 12 to 14, wherein the

transition metal content in the copolymer is 20 ppm or less.